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LUCERNE GROWING IN THE NELSON DISTRICT

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By
T. H. EASTERFIELD, Director of the Cawthron Institute;
and
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Lucerne Growing in the Nelson District

(A PAMPHLET FOR FARMERS)

Written at the request of the Lucerne Committee of the Nelson Chamber of Commerce and Nelson Agricultural and Pastoral Association.

By
T. H. Easterfield, Director of the Cawthron Institute ;
and
T. Rigg, Soil Chemist to the Cawthron Institute.

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Lucerne Growing in the Nelson District.

> "*A rational system of agriculture cannot be formed without the application of scientific principles.*"—LIEBIG.

WHY FARMERS SHOULD GROW LUCERNE.

Lucerne should be grown wherever possible because—

It is one of the most valuable fodder crops known.

It has a long growing season, during which it yields several heavy crops of fodder.

It has an almost unrivalled value as a supplementary fodder crop during the dry months of the year.

It enriches the soil with nitrogen, one of the most essential of plant foods and one of the most expensive to purchase. It also drains and aerates the subsoil.

VALUE AS A FODDER.

Lucerne may be fed with excellent results to cattle, horses, sheep, pigs, or poultry, either as a soiling crop, hay, ensilage, or by grazing. The plant is particularly rich in protein, and consequently is of especial value for increasing meat, milk, and egg production.

The actual feeding value of lucerne hay based on the amount of contained digestible matter is 30 per cent. greater than that of clover hay, and 100 per cent. greater than that of Timothy hay. Green lucerne, likewise, has a higher feeding value than either grass or young green cereals.

HIGH YIELD AND CONTINUOUS GROWTH.

Not only is lucerne a more nutritious fodder than those in common use in the Nelson district, but land in lucerne produces much more fodder than the same area in grass or oats. A good field of lucerne may give 6 tons of hay per acre, while an average field will give about 4 tons per acre.

Grass-land, on the other hand, will give only 1½ to 2 tons of hay per acre, and oats will average little more than 1½ tons in the Nelson district.

Another great point in favour of lucerne is the fact that it yields fodder continuously from October to June. In the dry months of summer and autumn, when grass pastures are parched and there is little green feed available, lucerne can be relied on, if properly established, to give one or two cuttings, each of which will average one ton of hay per acre.

GREAT VALUE AS A SUPPLEMENTARY FODDER CROP FOR DAIRY FARMERS.

It is impossible for the dairy farmers of the Nelson district to maintain the full milk output of their cows unless they grow supplementary fodder crops to tide them over the dry months of January, February and March. If grass is solely depended upon for fodder, the cows are reduced almost to maintenance rations during this period of the year, and the milk supply is greatly reduced. By supplying a ration of lucerne in addition to the feed which the cows can obtain from grass pastures, they are kept in full milk, to the great profit of the farmer.

Mr A. H. Cockayne has assessed the value of green lucerne during this period of the year at £3 per ton when reckoned in terms of butter fat at 1s 8d per lb. Since an acre of lucerne during the dry months of the year may yield 6 tons of green fodder, the value per acre for this period alone may be £18. A good field of lucerne will keep in full milk at least double the number of cows that could be maintained by grassland of equal area.

There is much land in the Nelson district which produces less than one ton of chaffed oats per acre, or which, when in grass, feeds less than half a sheep per acre. On such land a relatively poor growth of lucerne, lasting only for a few years, will often be found more profitable than grass or oats. Moreover, the preparation of the land and growing of the lucerne will pave the way for greatly increased yields of other crops which may follow after the lucerne is ploughed in.

Although the yield of certain other supplementary fodder crops such as maize, turnips, and mangolds is greater than that of lucerne, the growth of these crops involves much more labour annually in the preparation and cultivation of the soil, and in most cases in the harvesting and cartage of these crops. Lucerne has the great advantage that, once firmly established, it will give satisfactory yields of fodder for five to seven years, or even longer, with but small expense for manuring and cultivation. Owing to unfavourable weather conditions, maize, turnips, and mangolds may not be available at the time when supplementary fodder is most urgently required. Lucerne, however, is always available and ready for use even at times when other green feed is almost unprocurable.

ENRICHMENT OF THE SOIL.

Some farmers have expressed the fear that lucerne, by reason of the large amount of fodder removed each year from the land, will exhaust the soil of plant foods. It is true that lucerne does remove considerable quantities of certain plant foods from the soil, but owing to the deep-rooting habit of the plant this loss is distributed throughout a very large depth of soil and subsoil. The loss of plant food, even if the whole of the fodder is removed from the land, will therefore be relatively small in the topsoil, and is more than compensated for by the large gains which result in the nitrogen content of the soil in which lucerne is growing. This gain in the nitrogen content of the soil results from the activities of special bacteria which live in association with the lucerne plant, and are plentiful in the root nodules or tubercles which occur on thriving lucerne plants. They obtain nourishment from the plant, and in return supply the lucerne with nitrogen compounds prepared by them from the air. The lucerne thus obtains practically the whole of the nitrogen required for tissue building from atmospheric sources. The roots and stubble contain large stores of nitrogen compounds which when ploughed in quickly become available for subsequent crops. The roots and stubble of a certain lucerne field which had been down for five years were found to contain 229lbs of nitrogen per acre. This amount of nitrogen is contained in 10cwt of ammonium sulphate, which costs at the present time £10 to £12.

The following instance of the value of lucerne as a soil improver is taken from the records of the Rothamsted Experimental Station: Two plots which had been growing lucerne and beans respectively for some years were ploughed up and sown with wheat in five successive years. During this period the wheat grown on the former lucerne plot gave a total of 35 bushels per acre more than the plot which was formerly in beans. At the end of five years the wheat grown on the lucerne plot was yielding 50 per cent. more than the wheat grown on the bean plot.

Apart from the manurial effect due to the food stored up in the lucerne roots and stubble, the fertility of the land is increased by the improved aeration and drainage brought about by the deep-rooting habit of the plant. .

THE MOST FAVOURABLE CONDITIONS FOR LUCERNE GROWING.

Although lucerne can be grown profitably under a wide range of conditions which are not ideal for its culture, maximum yields may be expected only if the right soil and climatic conditions are present and if adequate care has been taken in the selection of the variety, in the preparation of the seed-bed, and in the cutting and cultivation of the lucerne stand.

SOIL AND CLIMATIC CONDITIONS

Lucerne is a deep-rooting plant, which grows best under warm, equable climatic conditions. In favourable localities where deep friable soils occur, its roots may penetrate to a depth of 10ft to 20ft. The reason for the continuous prolific yield of lucerne lies largely in the fact that its deep-rooting habit gives the plant access to stores of food and water which cannot be obtained by shallow-rooted crops. In order that lucerne may reach its maximum development it is therefore essential that the soil, subsoil, and substrata shall be permeable to the lucerne roots. The subsoil and substrata should contain no hard pan or heavy, cold clay, which would prevent the lucerne roots from penetrating at a rapid rate. Alluvial silts, sandy loam soils, or loamy soils underlaid by sand are naturally suited to the lucerne plant, and give the greatest yields of green fodder or hay.

Since an acre of lucerne may yield as much as 25 tons of green fodder in one season, it is obvious that the lucerne must have access to large supplies of water, so that the required mineral constituents may be removed from the ground to the plant. Unless the roots of lucerne can reach underground supplies of moisture it is impossible to expect quick growth of the plant in the dry summer months. If, however, underground water is too near the surface, the roots of the lucerne plant will have a very restricted range, and if stagnant water be near the surface, the lucerne will quickly die out. The production of large yields of fodder from lucerne therefore demands not only a deep permeable soil, but permanent water at a suitable depth. In silty or fine sandy soils water rises more readily by capillary action than in coarse sandy soils or gravelly loams. In the case of the coarser-textured soils the water level should be nearer the surface, lest the plants suffer from drought before the roots have penetrated to the moist substrata.

Lucerne thrives best on fertile soils well supplied with lime, and requires comparatively large quantities of phosphatic, potassic, and lime compounds in order that a high yield may be maintained. Unless the soil is well supplied with carbonate of lime the soil bacteria living in association with the lucerne plant are unable to perform their proper function. The plants are thus deprived of the nitrogenous compounds which the bacteria manufacture from the air. On acid soils these bacteria are frequently absent, and care must therefore be taken to inoculate the field before sowing the lucerne. A good supply of carbonate of lime in the soil and the presence of the requisite soil bacteria are two conditions absolutely essential to healthy thriving lucerne.

Since lucerne seed is small, containing little reserve food for the nourishment of the young plant, adverse climatic conditions seriously affect the growth of the plant in its early stages. Severe drought or frost will both prove disastrous until the root is firmly established. Lucerne thrives best in a climate with a moderate rainfall free from extremes of heat and cold. Even when well established its growth is checked by severe frost, and large yields of fodder are seldom obtained, without irrigation, if the rainfall is less than 36 inches per annum. The average rainfall in Nelson City during the last 37 years has been 37.37 inches.

SUITABLE VARIETIES.

Certain varieties of lucerne are famed for their drought-resisting qualities; others are noted for their ability to resist frost. These varieties are valuable for the countries in which severe climatic conditions are experienced, but, as a rule, do not give such high yields as those grown in more temperate climates. Peruvian, Algerian, and French lucerne are well-known varieties which do best in mild climates. Many strains of these varieties have been developed in different countries, and are now known by local names such as Marlborough or Hunter River. The exact derivation of these strains is in some cases hard to trace. It has been found that the strains which have been produced locally are usually more successful for the particular soil and climatic conditions than the newly imported seed of the parent variety. For this reason, Marlborough lucerne is likely to be more suitable for the Nelson district than freshly imported seed from other countries. It is quite possible that by suitable selection of the New Zealand grown plants, or by the introduction of new varieties, which would need to be acclimatised, variety strains might be produced which would be even better than the Marlborough. Until more evidence is forthcoming in favour of other varieties it is inadvisable to sow, on an extensive scale, any other than Marlborough seed.

NEED OF A GOOD SEED-BED.

Failure may be expected if the seed-bed be infested with weeds or the surface be rough and lumpy at the time of sowing.

The rate of growth in the early stages of lucerne plants is slow, and the young plant is easily killed by adverse conditions. Consequently on ill-prepared soils, it is frequently smothered by weeds which germinate at the same time as the lucerne seed. Care must therefore be taken to secure a clean seed-bed before sowing. The seed-bed must be deep, but firm underneath. The surface must be fairly smooth with a fine surface tilth.

CARE OF THE LUCERNE STAND.

In order to secure the best results from lucerne, it must be cut at the proper time and receive adequate cultivation. During the first two years it is not advisable to graze lucerne, since stock, particularly sheep, are apt to eat the crowns off or pull the plants out.

Lucerne should not be cut too closely, lest injury be done to the young growth which will make the next cutting of fodder. If cultivation is not given, weeds will infest the ground and cause great reduction in the yield of fodder. Cultivation keeps down weeds, ensures a better distribution of the bacteria in the soil, conserves moisture, aerates the soil and releases plant food.

CONDITIONS WHICH MAY CAUSE FAILURE.

Failure in lucerne culture is likely to occur under any one or combination of the following conditions:—

(1) If the subsoil is impermeable to lucerne roots either by reason of a hard pan or of a stiff cold clay subsoil which is badly drained.

(2) If the water level is too high, particularly if this water is stagnant.

(3) If lucerne is sown on acid soils which have not been thoroughly limed.

(4) If it is sown on soil lacking the necessary soil bacteria without first inoculating the soil with these bacteria.

(5) If it is sown on soils, very deficient in plant food without the employment of phosphatic and potassic fertilizers.

(6) If it is sown on a poorly prepared and ineffectively weeded soil, or if it is sown at an unfavourable time when drought or frost are likely to occur.

HOW SUCCESS MAY BE INSURED.

SELECTION OF THE FIELD.

A field should be selected in which soil conditions correspond as closely as possible to those which have been previously mentioned as most favourable to lucerne. The subsoil of the field should be permeable—the soil should be well drained and free at all times from surface or flood water. Frequently stiff soils which are inclined to be cold and wet can be made suitable for lucerne, if they are properly drained and subsoiled. If possible land should be chosen which is in good "heart" or condition.

THE PREPARATION OF THE LAND FOR SOWING.

The preparation of the land for lucerne is just as important as the selection of a suitable field. There are more instances of failure due to lack of cultivation, liming, and manuring than of failure due to unsuitable soil. Sometimes it will pay the prospective grower to spend two years in cleaning a dirty field and securing satisfactory tilth before attempting to sow lucerne. This is particularly true of poor stiff soils or very droughty soils. It is not necessary that the land should be idle for the whole of this period, for root crops or potatoes can be grown concurrently with the cleaning of the land. Stiff soils should receive adequate subsoiling and manuring while droughty soils should be improved by the ploughing under of green crops. Fields which are naturally suited for lucerne culture by reason of their fertility and permeability frequently require six months' preparation before seeding.

The exact procedure of ploughing and cultivation in preparing land for lucerne must depend upon the past history and peculiarities of the land. No hard and fast rules can therefore be laid down. The object of the grower must be to secure a deep seed-bed free from weeds and in a satisfactory state of tilth. Summer is undoubtedly the best time to kill weeds, as the warm weather encourages rapid germination of weed seeds, while cultivation in exposing their roots to the sun quickly kills the growing weeds. One deep ploughing to a depth of 6in. or 8in. should form a part of the preparation of every soil. This should be undertaken at least two months before the time for sowing, in order that weed seeds brought to the surface by ploughing may have time to germinate and be eradicated before the lucerne is sown. After this ploughing, disc cultivation and harrowings will be sufficient to secure a satisfactory tilth, and will keep the land free from weeds. As a rule, it is inadvisable to plough the land immediately before sowing, on account of the danger of bringing more weed seeds to the surface. These will germinate at the same time as the lucerne seed and compete with the plants for light, air, and plant food.

A firm seed-bed with a fine surface tilth is essential to success, and on this account the land must be well rolled immediately before sowing.

LIMING.

Most of the soils of the Nelson district are acid, and must be limed if the best results are to be obtained. The quantity of lime required on different soils varies greatly. The average "lime requirement" for all classes of soil in the district is about two tons of ground limestone per acre. In the appendix of this pamphlet a list is given of the "lime requirements" of the various soils of the district. Farmers, therefore, will have little difficulty in ascertaining the quantity of lime which should be applied to their land in order to neutralise soil acidity. The lime may be applied as slaked lime or ground limestone. It is best applied to the land after the last ploughing, but well before the time for sowing. The lime should be well worked into the soil with the disc cultivators or harrows. If possible the land should be limed one to two months before the date of sowing. As a general rule, lime should not be ploughed in, for the soil bacteria whose activities are dependent upon a supply of free lime are most active in the top 6in.-9in. of soil. In some cases, however, it may be found advantageous to plough under a quantity of lime in order to sweeten and render stiff subsoils more permeable to the lucerne roots. If this is done, the requisite dressing of lime must also be applied to the surface soil and incorporated with it in the manner which has been indicated.

MANURING.

There is much difference of opinion on the question of manuring lucerne, but this divergence is probably due to the fact that different observers have drawn conclusions from observations on soils of widely different properties and under different climatic conditions. Deep soils which are naturally fertile and which have been kept in good condition require little if any manure. On the other hand, if the soil and subsoil are naturally poor in plant food or if the subsoil allows only a slow penetration of the roots, exhaustion from lack of plant food is likely to occur. On such soils, manuring will generally be beneficial and even necessary to maintain the vigour of the plants. Heavy phosphatic manuring in the preparation of the soil for lucerne is a common American practice. Phosphatic manures assist the establishment of the young plant and enable it to develop quickly a vigorous root system. Unfortunately manuring will also encourage a more vigorous development of weeds, but if the lucerne be sown in the early summer with a comparatively long growing period before the frosts of winter check its growth, there will be little danger of its being choked by weeds. Some soils of the Nelson area are highly deficient in phosphates, and must be manured with phosphatic fertilizers. Sandy soils are usually low in potash, and on such soils heavier dressings of potassic fertilizers than would be employed for loamy soils are advisable.

The type of manuring and the quantity necessary for different soils varies with the soil type. A list of manurial mixtures suitable for lucerne, when grown on different soils, is given in the appendix to this pamphlet. In certain cases, systematic experiments extended over a period of years will alone show whether manuring for lucerne is profitable.

If manures are applied in the preparation of the seed-bed, they should be drilled or broadcasted and harrowed into the soil two or three days before sowing the lucerne.

SOIL INOCULATION.

This should be performed immediately before the sowing of seed. The soil used for inoculation must be obtained from a lucerne patch which has been established for several years and which is thriving well. The dark green colour of the leaves and vigorous growth are generally indications of the presence in the soil of the bacteria which live in association with lucerne. The presence of white or greyish white tubercles on the fine roots is evidence of the presence of the desired bacteria. If the plants are found to possess tubercles or nodules, soil should be taken down to a depth of 6in.-9in. Care must be taken that the inoculating soil is not obtained from diseased or weedy lucerne fields. The soil should be sieved and used as soon as possible

About 2cwt of the soil is required for an acre of lucerne. The soil should be broadcasted over the field in dull light, as exposure to bright sunlight kills the bacteria. Harrowing should immediately follow the broadcasting of the inoculating soil. After rolling to produce a firm seed-bed the field is ready for sowing the lucerne.

TIME AND MANNER OF SOWING.

The time of sowing lucerne seed must depend to some extent on the condition of the field. Its tilth, freedom from weeds, its texture, and its moistness will all be factors in deciding the exact time when a field should be sown. • Severe frosts are fatal to very young lucerne plants, consequently sowing should be carried out in the spring, after the period of heavy frosts, or in autumn, well before frosts have commenced.

In the Nelson district the favourable period of sowing, considering solely the adverse nature of frost, will be from the middle of October to the end of February. As the young lucerne plant is easily killed by drought, it will be advisable to avoid sowing on droughty soils in December and January, unless the season is wet. October and November in the spring, and February in the autumn are thus the best months for sowing, if the seasons are normal.

Lucerne may be broadcast or sown in drills. In the Nelson district broadcasting has been the general method of sowing and this method has been successful in a number of cases which have come under our observation. If the prepared seed-bed is free from weeds, and the soil is fertile and in a satisfactory state of fine tilth, there seems to be little advantage in drilling over careful broadcasting. The good condition of the seed-bed ensures both satisfactory germination and freedom from serious weed troubles. If the soil is fertile, the lucerne will develop vigorously and maintain its vigour with little cultivation for several years.

In the case, however, of soils which are inclined to be weedy, or which are ill-supplied with plant food or moisture, it seems advisable to drill in 14 in. or 21 in. rows. A more even stand is thus obtained and cultivation can be commenced at an earlier stage, thus preventing the lucerne from being choked by weeds. The cultivation also conserves the moisture in the soil, thereby assisting the young lucerne plants to become established. Subsequent manuring of the lucerne, if required, can be more effectively carried out if the seed is drilled in 14 in. or 21 in. rows, than if broadcast. Where lucerne is grown solely for fodder, drilling in 21 in. rows is particularly suitable for poor or droughty soils, while 14 in. drilling seems preferable for moist fertile soils. If lucerne is grown for seed, the plants require space in order that heavy yields of uniformly ripe seed may result. Under these circumstances, drilling in 21 in. rows will probably be found more suitable than broadcasting or drilling in rows of smaller width.

Sometimes lucerne is drilled in 7 in. rows. From the point of view of keeping down weeds or ease of cultivation of the field, drilling in 7 in. rows possesses little advantage over broadcasting, for horse cultivation is impracticable between such narrow rows. A more even stand, however, generally results unless the broadcasting has been carefully done.

SOWING WITH A NURSE CROP.

Except on sand there is little justification for the practice of sowing lucerne with a nurse crop such as peas or oats. If lucerne is sown at the proper time and if the ground has been carefully prepared, the use of a nurse crop will do more harm than good. The nurse crop will compete with the young lucerne for plant food and moisture much to the detriment of the lucerne. Nurse crops are useful on sandy soils which are apt to be blown by the wind. A nurse crop, such as oats, drilled at right angles to the direction of the prevailing winds, hinders the young lucerne plants from being covered by drifting sand. If such a nurse crop is used, it should be cut as soon as the lucerne has developed sufficiently to be out of danger.

QUANTITY OF SEED.

Fifteen pounds of lucerne seed per acre is the quantity usually sown. The state of the ground and the method of sowing should, however, determine the amount of seed to be used If the seed be broadcast and the seed-bed good, 15 lbs. of seed per acre is not necessary. If all the seeds in 15lbs. germinated nearly 80 plants per square foot of ground would result. This numer of plants is far too high to allow satisfactory growth and development to take place. Though this number of plants never results experiments have shown that on many soils a lower rate is sufficient. If the seed bed is in a satisfactory state of tilth and moistness, 10lbs. of seed, carefully and uniformly broadcast· should be quite sufficient to produce a thick and even stand of lucerne. Where the seed-bed is lumpy or irregular, or where the soil is poor or droughty, 15lbs. of seed should be used for broadcasting.

If the seed be drilled in 7 in. rows, the same rate of seeding should be adopted for similar conditions of soil as has been recommended for broadcasting. Seed drilled in 14in. rows will amount to only one half of that required for drilling in 7in. rows. In this case, the drilling machine should be set to sow at the same rate as that recommended for similar soil conditions in 7in. drilling. Since half of the drill openings are closed when 14in. rows are drilled only one half of the seed used for 7in. rows will be sown. Five pounds of seed should be sufficient for an acre of lucerne drilled in 21in. rows. A fine level rolled surface is required for sowing, and it is important that the seed be covered but not too deeply. About ¾ to 1in. is the best depth to plant lucerne seed on loamy soils, while 1½in. will be found more suitable for sandy or coarse textured soils. If sowing is accomplished by broadcasting, it is the custom to sow one half of the seed in one direction, and the other half at right angles to the line of the first sowing. The seed is then covered by using a light harrow.

If a lucerne seed drill is not available, drilling may generally be accomplished through the turnip or rape attachment of an ordinary grain drill. The fertilizer distributor of an ordinary combined grain and manure drill may also be used, provided the volume of the lucerne seed is made up with finely sieved dry soil or sand. It is generally necessary to experiment on a hard surface before drilling lucerne seed, in order to ascertain that the machine is set at the proper rate of sowing and that the seed is being dropped uniformly from the drill openings.

TREATMENT OF THE FIELD AFTER SOWING.

EARLY TREATMENT

Weeds are the greatest danger to young lucerne plants. If the lucerne field has been broadcast, it is not possible to do any cultivation until the lucerne roots are well down into the soil. The only method of checking weeds under these circumstances is the mowing of the field. This can be done, if weeds are troublesome, when the lucerne is five or six inches high.

Cutting should not be too close to the ground, as serious retardation in the growth of the lucerne will result. This first cut, if not too heavy, is usually left on the surface of the ground as a mulch. A second cutting should be made as soon as practicable to hold weeds in check. The second cut may be removed When the lucerne is so far advanced that it will not readily pull out cultivation with the tine harrows or the spring tooth cultivator may be commenced. In the case of lucerne drilled in 14in. or 21in. rows, cultivation with the spring tooth cultivator may be commenced at an earlier stage and, from the outset; the land may be kept fairly clean from weeds.

CULTIVATION.

When lucerne has become firmly established cultivation should be frequent and thorough. The most successful growers in the Nelson district, cultivate after each cutting, and in addition give a very thorough cultivation in the late winter, before spring growth has commenced.

The spring tooth cultivator of the non-rigid type and the tine harrow are the implements most generally recommended for lucerne cultivation. The disc harrows with the discs set straight, so that the crowns of the plants will not be sliced off, are sometimes used, but injury to the plants often results from their use. A rotary disc cultivator, which has been specially constructed for lucerne cultivation, is well spoken of, particularly for fields which have been broadcast.

THE HANDLING OF THE CROP.

CUTTING THE LUCERNE.

It is important that lucerne be cut at the right stage of growth. Delay in cutting involves loss in digestibility of the fodder and a retardation in growth of the subsequent crops. Lucerne should be cut as soon as the new growth starts away from the crown of the plant. This stage is generally reached before one-tenth of the field is in bloom. Cutting must not be so close as to injure the new growth at the base of the plant. The cut should be removed as soon as practicable, otherwise harm to the stand will result.

HAY-MAKING.

Weather conditions in the spring are not, as a rule, suitable for making the first cut of lucerne into hay. This cut must, therefore, be either fed to stock or made into ensilage. Haymaking can usually be undertaken with the 2nd, 3rd, and even the 4th cut. Showery weather prevents satisfactory curing and drying and the crop should not be cut for hay while wet with rain or dew. Cutting for hay should therefore only be decided on if there is a reasonable prospect of fine weather at the time when the crop is ready.

If hot weather prevails at the time of cutting care must be taken not to allow the lucerne to lie too long in the swathes or windrows otherwise the tender leaves will dry out too quickly while the stem is still sappy. If this happens a large percentage of the leaves which constitute the most nutritious part of the hay will drop off and be lost. When the leaves have slightly wilted the lucerne should be made into small cocks and allowed to cure. The hay should not be stacked until the stems have lost their sappiness and the hay has a crisp feeling throughout. If lucerne is stacked while the stems are sappy there is serious danger of mould, charring or even burning the stack. As lucerne hay does not shed rain well a covering must be placed over the top of the stack.

FEEDING AND GRAZING LUCERNE.

Lucerne may be fed to all classes of stock, as a part ration, but it does not constitute a balanced ration. It is rich in protein and is profitably fed to stock in conjunction with such foods as grass, maize, turnips and mangolds which are rich in carbohydrates. If lucerne is fed to stock as an entire ration full use is not made of the valuable protein which it contains. Stock seem to prefer lucerne hay to green lucerne, and the hay is a safer food than the green crop. Cows and sheep are likely to suffer from "hoven" or "bloat" unless care is exercised in feeding green lucerne or in grazing on it.

The practice of soiling lucerne to stock is much preferable to grazing. In soiling it is advisable to leave the cut lucerne to wilt for 24 hours before feeding. This lessens greatly the danger of the cattle bloating, but even under these circumstances the lucerne should be fed only as a part ration. If a field is being used regularly for soiling, it should be mowed in such a way that by the time the field has been cut over, the portion where mowing commenced is ready for a second cut.

The practice of grazing lucerne is attended with a certain amount of risk to stock as well as to the plants. Stock should not be turned into a lucerne field while hungry and should only be allowed to graze for a short time. About three-quarters or 1 hour per day is considered a safe practice in the autumn months when other feed is scarce. Grazing is also attended with danger to the lucerne stand. Sheep in particular, if kept on too long may eat out the tender growth which would produce the next cut of fodder. If the ground is damp the surface becomes puddled and this militates against subsequent growth unless thorough cultivation is given, after the stock has been removed. The dung of grazing stock introduces weed seeds which are harmful to the permanency of the stand. In no case should grazing be allowed on a lucerne field during the first two seasons, i.e., while the plants are still tender.

ENSILAGE.

Lucerne, when made into ensilage, provides succulent fodder for stock. A supply of ensilage is most valuable as an emergency fodder for those times when green feed is unprocurable. It is particularly valuable in districts liable to droughts which result in failure or greatly diminished yields of all green crops. Ensilage is made by allowing an initial fermentation of the green lucerne to take place. When fermentation has gone far enough, it is arrested by packing tightly. This prevents decay and the lucerne is preserved in a form suitable for feeding to stock.

SUMMARY OF DIRECTIONS FOR LUCERNE CULTURE.

(1) Select a field which is well drained, free from flood or standing water. The soil and subsoil should be permeable to lucerne roots and the field, if possible, should be in good heart.*

(2) Prepare the field thoroughly by deep ploughing and constant cultivation in order to secure a fine seed bed free from weeds.

(3) Lime the soil in order to neutralize soil acidity, thus making conditions favourable for the activity of the bacteria associated with lucerne.†

(4) Manure poor soils.‡

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*See appendix I. for notes in regard to suitable soil types.
†See appendix III. for quantity of lime required on different soils.
‡See appendix IV. for type and quantity of manure for different soils.

(5) Inoculate the lucerne field by broadcasting and harrowing in 2 cwt per acre of soil taken from a well established and thriving lucerne field.

(6) Sow Marlborough lucerne. The seed-bed must be firm. The rate of seeding varies with the type of soil, the condition of the seed-bed and the manner of sowing. As a general rule 15 lbs of seed are required.

(7) Check weeds in the early stages by cutting in the case of broadcasted seed. By cultivation if the seed has been drilled.

(8) Cultivate the lucerne field as soon as the plants are established.

(9) Do not graze heavily and allow no grazing during the first two seasons.

APPENDIX.

The following information will enable any farmer to determine the class of soil on his farm and thus to be in a position to utilize the appended tables of "lime requirement," manurial mixtures, etc.

I. OUTLINE OF SOIL DISTRIBUTION IN THE NELSON DISTRICT.

For the purpose of description the district may be divided into five sectors:—

A. Wakapuaka.
B. Nelson City and Stoke.
C. The Waimea Plains.
D. The Moutere Hills.
E. Motueka.

A. THE WAKAPUAKA SECTOR:

The Wakapuaka sector has not been examined in sufficient detail to make possible a clear demarcation of the different soils occurring in this area. At least three types of soil have been observed. These are (1) Wakapuaka silt loam; (2) Wakapuaka loam; (3) Wakapuaka clay loam.

(1) Wakapuaka silt loam occurs on the flat land between the main road and the Boulder Bank. A portion of this area has been reclaimed in recent years.

(2) Wakapuaka loam is found in the valleys along the stream courses. This type is of comparatively recent alluvial origin.

(3) Wakapuaka clay loam is typical of the soil covering some, but not all of the hills flanking the main road.

B. NELSON AND STOKE.

In the Nelson and Stoke area there are at least six distinct soil types. These are: (1) Nelson loam; (2) Tahuna fine sand; (3 Port clay loam; (4) Stoke loam; (5) Stoke heavy loam; (6) Waimea clay loam.

(1) Nelson loam covers a considerable part of the flat area of the city. It is well exemplified in "The Wood" where it is used extensively for tomato culture.

(2) Tahuna fine sand covers an area stretching from the township of Tahuna to Quarantine road, Stoke. A smaller area occurs on the seaward side of the road at Mapua.

(3) Port clay loam is found on the greater part of the Port hills and the low-lying hills at the back of Stoke. It extends on these hills to a point south of Richmond. This type of soil is mainly used for sheep-farming.

(4) Stoke loam covers the principal part of the flat ground from Quarantine Road, Stoke, to a point south of Richmond. This soil is largely used for fruit-growing, although towards Richmond there is much mixed farming.

(5) Stoke heavy loam occurs in patches, over the Stoke loam area, and is associated with land lying, for the most part, at a slightly lower level than is the case with the Stoke loam. The land in the vicinity of the Stoke Freezing Works is typical of this soil type. It is mainly used for mixed farming.

(6) Waimea clay loam covers a narrow strip of country skirting the sea-coast from Stoke to the mouth of the Waimea river. Towards the Waimea river a lighter phase is encountered, further away from the sea. The whole of this soil type is either in pasture or is used for cereals.

C. THE WAIMEA PLAINS.

In the Waimea Plains sector there are four main types of soil which have been named as follows:—(1) Waimea gravel loam; (2) Waimea loam; (3) Waimea sandy loam; (4) Maitai shale loam. Smaller areas of Moutere loam, Waimea clay loam and Waimea peat also occur in this sector.

(1) The Waimea gravel loam covers a very extensive area of country between Richmond and Brightwater. The Waimea river roughly marks the western boundary of this soil type. It is used mainly for mixed farming. The principal crops are oats and barley.

(2) Waimea loam is typically represented in Waimea West and extends over a considerable area of flat land on the western side of the Waimea and on both sides of the Wai-iti river, from the sea to Wakefield. South of Brightwater this soil type is not quite so regular and is rather lighter in texture. This soil type is brown in colour, very fine in texture and easily distinguished from Waimea sandy loam which is, locally, called Maori gravel soil. Waimea loam is used principally for mixed farming. The chief crops are oats, barley and clover.

(3) Waimea sandy loam is the "Maori" gravel soil of Waimea West. It is principally confined to the flat land west of the Waimea river. This soil is also used for mixed farming. The principal crops are oats, barley and clover.

(4) Maitai shale loam has a restricted area. It occurs on the western flanks of the Heslington hills and extends some distance north and south of the Wairoa Gorge. It is used extensively for early peas and general cropping.

D. THE MOUTERE HILLS.

The Moutere hills sector extends from the sea to a point far south of Wakefield. It is bounded on the east by the Waimea Plains and stretches westwards almost to Motueka.

(1) The main type of soil is Moutere loam which is characteristic of the greater part of the Moutere Hills. Smaller areas of this soil occur on somewhat elevated ground in the vicinity of Richmond, Hope and Brightwater.

(2) Another soil type belonging to this sector is Moutere gravel loam. This occurs in the Moutere valley, extending from Lower Moutere nearly to Motueka. It is also found in the flat land in Redwood's Valley, Waimea West.

E. THE MOTUEKA SECTOR.

The Motueka sector has not been examined in detail, but the most prominent soil type is Motueka sand underlaid by a loam. This soil is of recent alluvial origin and is used extensively for fruit culture.

II. SUITABILITY OF NELSON SOILS FOR LUCERNE CULTURE.

1. SOILS WHICH ARE SUITABLE FOR LUCERNE CULTURE

Soil type.	Location.
a. Nelson loam.	Nelson city.
b. Maitai shale loam.	Western slopes of Hope and Heslington Hills.
c. Waimea sandy loam.	Waimea West.
d. Motueka sand.	Motueka.
e. Waimea loam.	Waimea Plains.
f. Stoke loam.	Stoke and Richmond.
g. Wakapuaka loam.	Wakapuaka.
h. Tahuna fine sand.	Tahuna and Mapua.

2. SOILS WHICH ARE NATURALLY UNSUITABLE FOR LUCERNE CULTURE.

Soil type.	Location.
*a. Waimea clay loam.	Stoke and Waimea Plains.
*b. Wakapuaka clay loam.	Wakapuaka.
c. Higher slopes of Moutere loam.	Moutere Hills.
d. Waimea peat.	Richmond and Appleby.

*Small areas of these two soil types where the location is favourable and the texture lighter than usual, will be found suitable for lucerne, provided that proper treatment to the land is given.

3. SOILS OF DOUBTFUL OR INTERMEDIATE VALUE FOR LUCERNE CULTURE.

(Named in order of probable suitability.)

Soil type.	Location.
a. Stoke heavy loam.	Stoke and Richmond.
b. Waimea gravel loam.	Waimea Plains.
c. Moutere gravel loam.	Moutere Valley.
d. Wakapuaka silt loam.	Wakapuaka.
e. Port clay loam.	Port and Stoke.
f. Moutere loam (lower slopes).	Moutere Hills, Richmond and Brightwater.

III. TABLE OF "LIME REQUIREMENT" OF NELSON SOILS.

	Ground limestone (tons per acre).
1. Wakapuaka Sector—	
Wakapuaka silt loam	1½*
Wakapuaka loam	—
Wakapuaka clay loam	2½*
2. Nelson and Stoke area.	
Nelson loam	Nil
Tahuna fine sand	2½
Port clay loam	2½
Stoke loam	2
Stoke heavy loam	2
Waimea clay loam	2⅔
3. Waimea Plains sector.	
Waimea gravel loam	1½
Waimea loam	1¾
Waimea sandy loam	1
Waimea peat	5
Maitai shale loam	1½
4. Moutere Hills sector.	
a. Highest slopes and bare ridges	4½
b. Lower slopes	3½
c. Lowest slopes	2⅔
(2.) Moutere gravel loam	2½
5. Motueka sector.	
Motueka sand	⅓*

*Few examinations of these soils have as yet been made. Note: The "lime requirement" of a soil is the quantity of ground limestone required per acre in order to neutralize soil acidity. The ground limestone may be replaced with equal effect by the use of slaked lime. If slaked lime is used only ¾ of the amount will be required.

IV. TABLE OF MANURIAL MIXTURES SUITABLE FOR LUCERNE ON THE SOILS OF THE DISTRICT.

Soil type.	Manurial mixture.
Nelson loam Maitai shale loam Motueka sand	No fertilizers required.
Stoke loam Stoke heavy loam Waimea loam Wakapuaka loam	A mixture of 2-3 cwt. superphosphate and ½ cwt. sulphate of potash per acre, harrowed into seed-bed before sowing.
Tahuna fine sand Waimea sandy loam Waimea gravel loam Wakapuaka silt loam	A mixture of 2-3 cwt. superphosphate and 1 cwt. sulphate of potash per acre, harrowed into seed-bed before sowing.
Waimea clay loam Port clay loam Wakapuaka clay loam	2-3 cwt. ground rock phosphate or basic slag to be ploughed in at time of sub-soiling. A mixture of 3 cwt. superphosphate and ½ cwt. sulphate of potash per acre, harrowed into seed-bed.
Moutere loam Moutere gravel loam	2-3 cwt. ground rock phosphate or slag to be ploughed in at time of sub-soiling. A mixture of 5 cwt of superphosphate, ½ cwt. sulphate of potash, and ½ cwt. ammonium sulphate per acre, harrowed into the seed-bed.

Note: The mixture for the seed-bed to be applied after liming and preferably two or three days before sowing.

V. SOIL FOR INOCULATION.

Arrangements may be made with the following farmers to supply soil for inoculation from their well-established fields of lucerne.

(1.) Wakapuaka:
F. H. Gill.

(2.) Nelson and Stoke:
A. Gilbert, R. Daggar, C. W. Pitts-Brown.

(3.) Richmond:
W. Maddox.

(4.) Appleby:
W. Neen.

(5.) Brightwater:
F. C. Page, A. J. McMurray.

(6.) Motueka:
C. N. Batchelor, "Meadowfield," Motueka.

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